The effects of CHD-FA on the absorption of minerals using the everted mouse gut model

Fulvic acid (FA) is a complex organic macromolecule widely distributed in nature. FA can be obtained from the environment via extraction methods or through the oxidation of substances such as coal or lignite. FA obtained through these methods has been seen to contain high levels of heavy metals and traces of herbicides and pesticides, thus rendering them harmful for human consumption.

A carbohydrate derived fulvic acid (CHD-FA) manufactured from a pure carbohydrate source following GMP standards has been produced for human use due to the many reported benefits of this type of compound. CHD-FA is devoid of heavy metals and other potentially toxic substances due to the defined starting materials and controlled manufacturing process, making it safe for use in humans.

Fulvic acids possess strong chelating abilities due to their large size, unique structure and abundance of oxygen-containing functional groups. FA is capable of binding to and forming complexes with numerous substances, including drugs (Mirza et al., 2011), organic pollutants (De Paolis & Kukkonen, 1997) and heavy metals and minerals (Buffle et al., 1977), whereby their solubility is affected.

Due to the known chelating potential of FA, there is a high possibility that CHD-FA could also form complexes with minerals and other nutrients in our diets. These complexes could result in increased or decreased absorption, which in turn changes the overall amount of themineral or nutrient absorbed. Changes in the amount absorbedcould have positive or negative effects on a person’s nutritional status and health. It is therefore important to look at the effect that CHD-FA could have on the absorption of essential minerals obtained in our diet.

In this study, the absorption of 5minerals:calcium, iron(II), iron(III) magnesium, and zinc was assessedwhen the minerals were given alone or in combination with CHD-FA.

The everted mouse gut model , originally described by Wilson and Wiseman in 1954 (Wilson & Wiseman, 1954)is a validated method for assessing GIT transport of substances that are normally absorbed from the digestive system. It is a technique involving the use of intact intestinal tissue dissected from mice andcan fairly accurately predict intestinal transport of substances in humans. The everted gut sac technique is a relatively inexpensive, simple, repeatable and reliable technique for assessing intestinal absorption. In addition, it allows for the absorption along different sites of the intestine (duodenum, jejunum, ileum and colon) to be assessed. This is important, as the amount of substance absorbed at each site is known to differ.

The everted mouse gut model was used in this study in order to compare the absorption of the minerals alone and in the presence of CHD-FA. The effect of the CHD-FA, via complexing, on the absorption of the mineral could then be compared to normal absorption when the mineral is ingested alone.

References

Buffle, J., Greter, F., Haerdi, W. (1977). Measurement of complexion properties of humic and fulvic acids in natural waters with lead and copper ion-selective electrodes. Anal. Chem., 49(2), 216-222.

DePoalis, F., Kukkonen, J. (1997). Binding of organic pollutants to humic and fulvic acids: influence of pH and the structure of humic material. *Chemosphere*, 34(8), 1693-1704.

Mirza, M.A., Ahmed, N., Agarwal, S.P., Mahood, D., Anwer, M.K., Iqbal, Z. (2011). Comparative evaluation of humic substances in oral drug delivery. Results. Pharma Sci, 1, 16-26.

Wilson, B. Y. T. H., & Wiseman, G. (1954). The use of sacs of everted small intestine for the study of the transference of substances from the mucosal to the serosal surface. *J. Physiol.*, *123*, 116-125.

Calcium

Results:

Graphs 1a-e(following page) show the results of calcium absorption for different anatomically distinct sections of the mouse intestine. The absorption of calcium alone (control) is compared to the absorption of calcium in the presence of typical CHD-FA concentrations expected in the GIT.

Graphs 1a-dshow the comparison of absorption between mineral alone or combined with CHD-FAfor the individual intestinal segments (duodenum, jejunum, Ileum and colon).

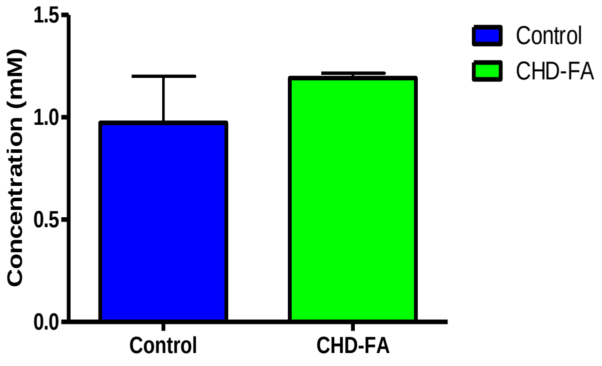
Graph 1e combinesthe results of **graphs 1a-d**.

Anincrease in the calcium absorption in the presence of CHD-FA was seen in all GIT segments.

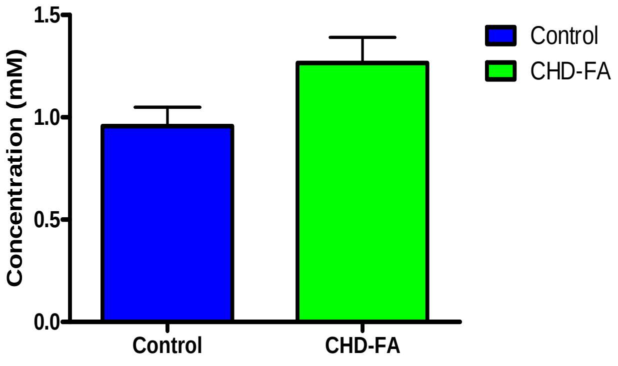
The ileum (**Graph 1c**) showed the greatest difference in calcium absorption.

Calcium

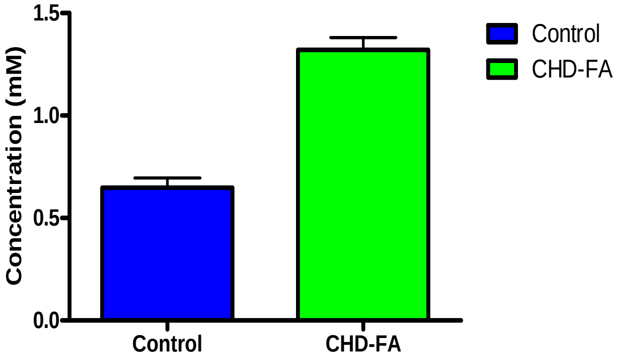
Graph 1a: Calcium absorption in the duodenum



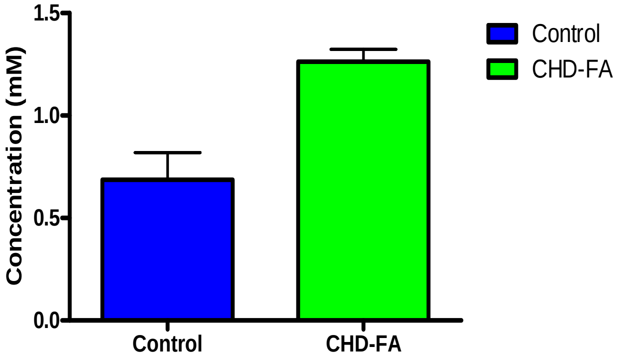
Graph 1b: Calcium absorption in the jejunun



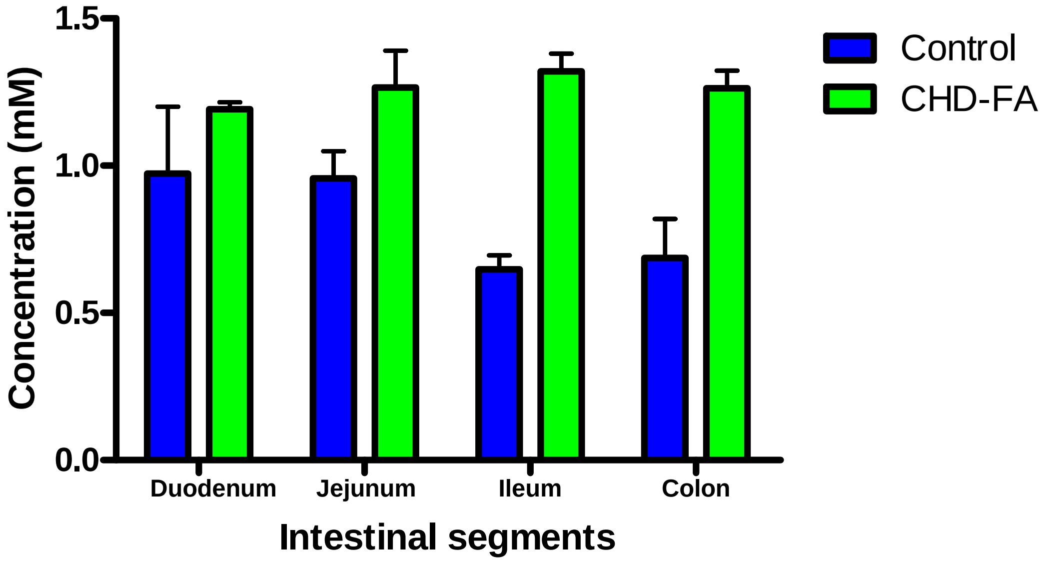
Graph 1c: Calcium absorption in the ileum



Graph 1d: Calcium absorption in the colon



Graph 1e: Comparison of calcium absorption across the different intestinal segments



Iron (III)

Results:

Graphs 2a-e(following page) show the results of iron(III) absorption for different anatomically distinct sections of the mouse intestine along the mouse intestine. The absorption of iron(III) alone (control) is compared to the absorption of iron(III)in the presence of typical CHD-FA concentrations expected in the GIT.

Graphs 2a-dshow the comparison of absorption between iron(III) alone or combined with CHD-FA for the individual intestinal segments (duodenum, jejunum, Ileum and colon).

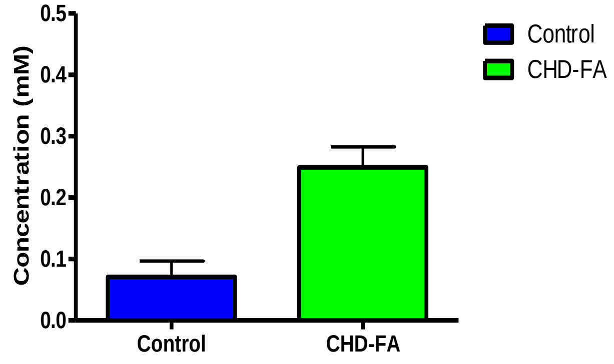
Graph 2e shows the combined results of **graphs 2a-d**.

An increase in the iron(III) absorption in the presence of CHD-FA was seen in all GIT segments.

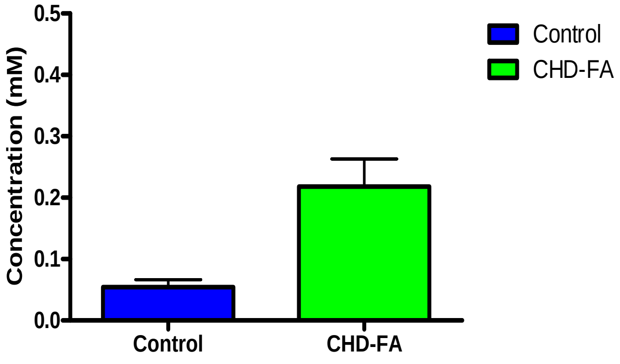
The ileum (**Graph 2c**) showed the greatest difference in iron(III) absorption.

Iron (III)

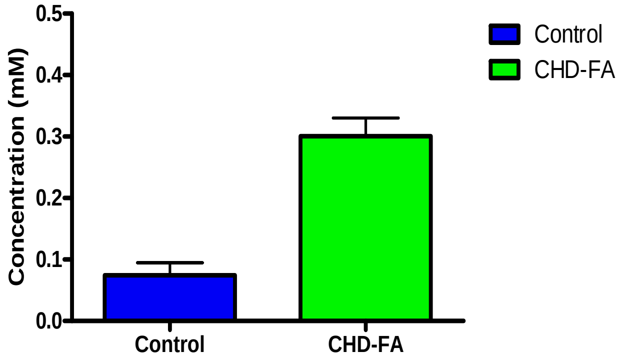
Graph 2a: Iron(III) absorption in the duodenum



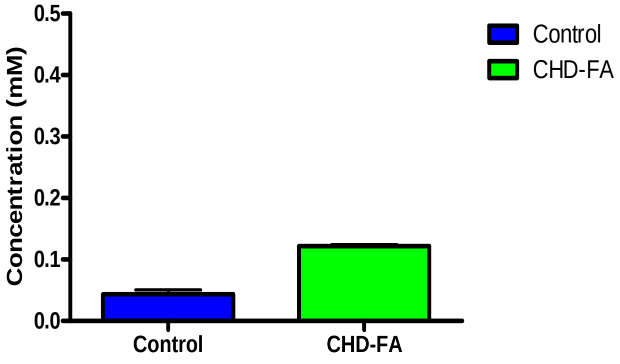
Graph 2b: Iron(III) absorption in the jejenum



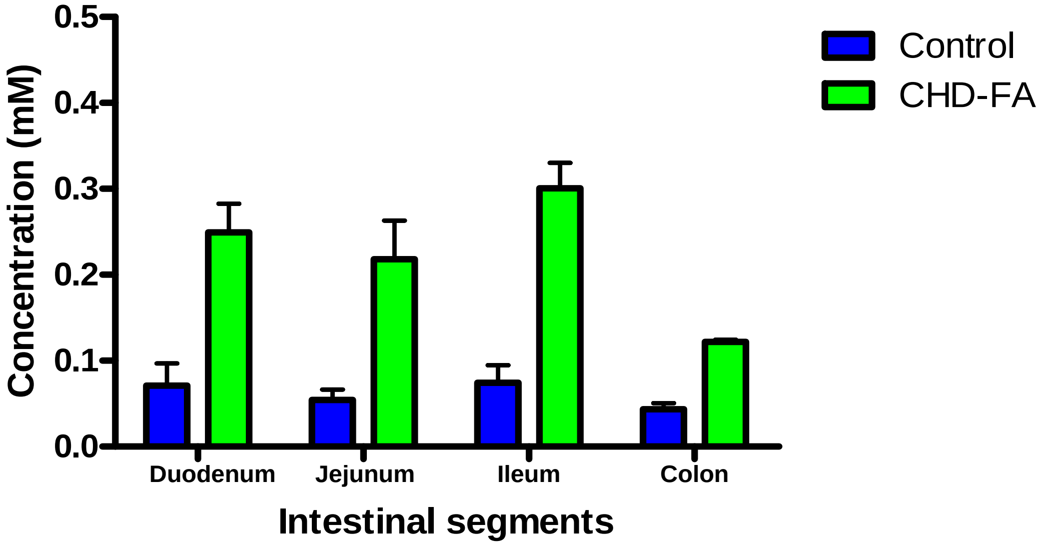
Graph 2c: Iron(III) absorption in the ileum



Graph 2d: Iron(III) absorption in the colon



Graph 2e: Comparison of iron(III) absorption across the different intestinal segments



Magnesium

Results:

Graphs 3a-e(following page) show the results of magnesium absorption for different anatomically distinct sections of the mouse intestine. The absorption of magnesium alone (control) is compared to the absorption of magnesium in the presence of typical CHD-FA concentrations expected in the GIT.

Graphs 3a-dshow the comparison of absorption between mineral alone or combined with CHD-FA for the individual intestinal segments (duodenum, jejunum, Ileum and colon).

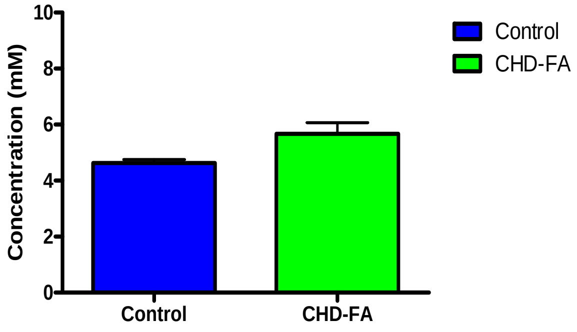
Graph 3e shows the combined results of **graphs 3a-d**.

A small increase in the magnesium absorption in the presence of CHD-FA was seen in all GIT segments.

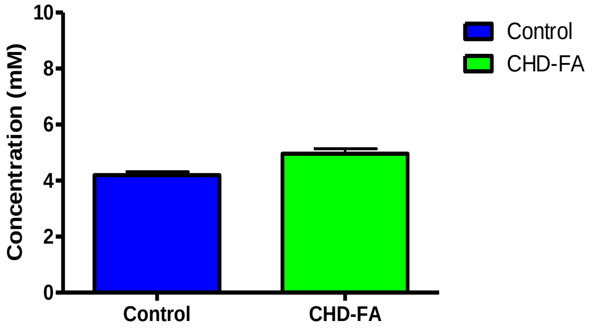
The duodenum (**Graph 3a**) showed the greatest difference in magnesium absorption.

Magnesium

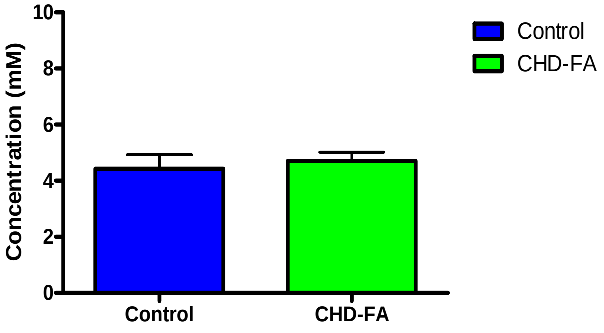
Graph 3a: Magnesium absorption in the duodenum



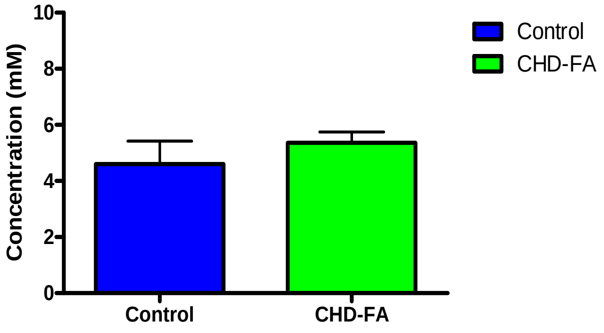
Graph 3b: Magnesium absorption in the jejunum



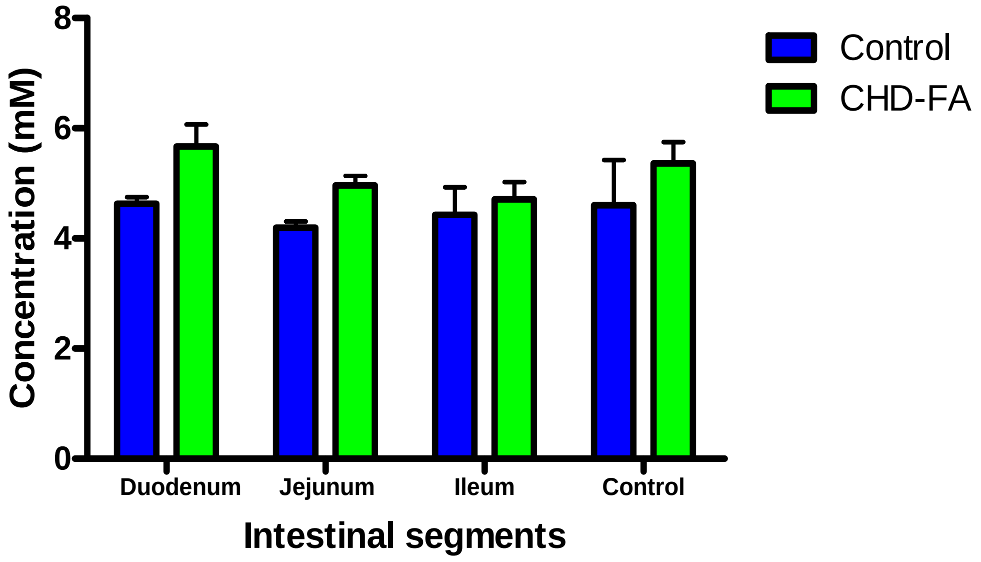
Graph 3c: Magnesium absorption in the ileum



Graph 3d: Magnesium absorption in the colon



Graph 3e: Comparison of magnesium absorption across the different intestinal segments



Iron(II)

Results:

Graphs 4a-e(following page) show the results of iron(II) absorption for different anatomically distinct sections of the mouse intestine. The absorption of iron(II) alone (control) is compared to the absorption of iron(II) in the presence of typical CHD-FA concentrations expected in the GIT.

Graphs 4a-dshow the comparison of absorption between mineral alone or combined with CHD-FA for the individual intestinal segments (duodenum, jejunum, Ileum and colon).

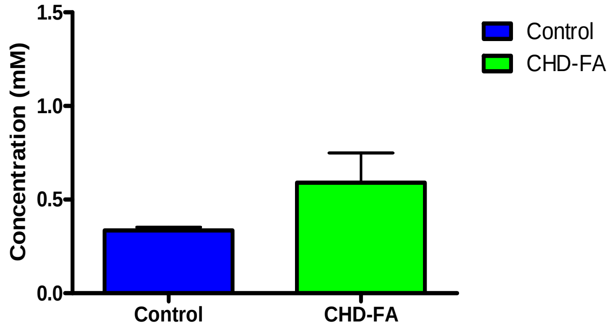
Graph 4e shows the combined results of **graphs 4a-d**.

An increase in the iron(II) absorption in the presence of CHD-FA was seen in all GIT segments.

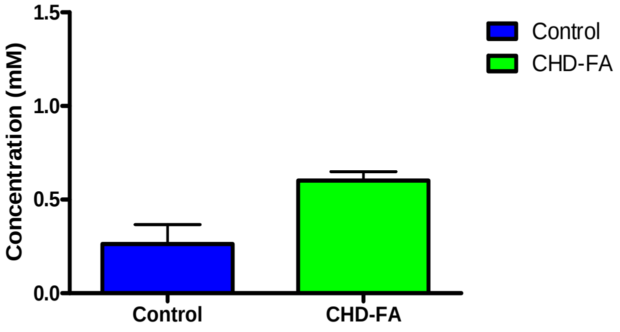
The duodenum and ileum (**Graphs4a & c**) showed the greatest difference in iron(II) absorption.

Iron (II)

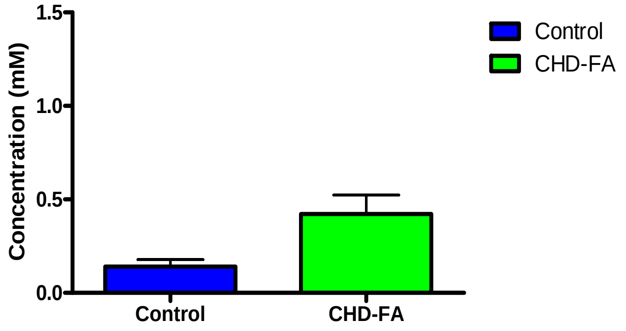
Graph 4a: Iron(II) absorption in the duodenum



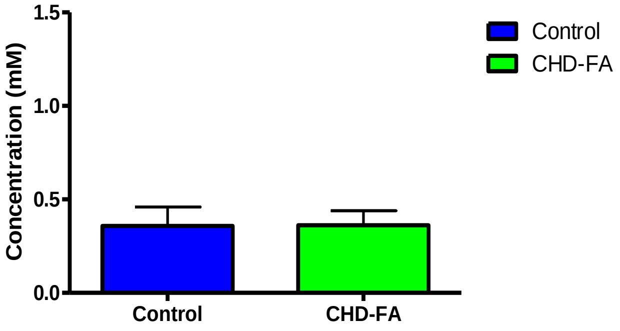
Graph 4b: Iron(II) absorption in the jejunum



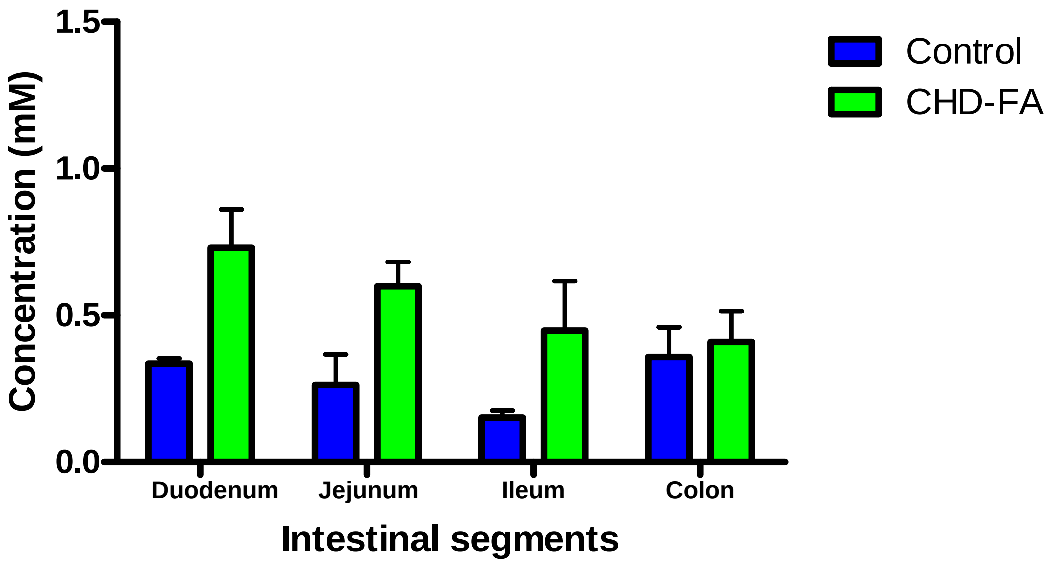
Graph 4c: Iron(II) absorption in the ileum



Graph 4d: Iron(II) absorption in the colon



Graph 4e: Comparison of iron(II) absorption across the different intestinal segments



Zinc

Results:

Graphs 5a-e(following page) show the results of zinc absorption for different anatomically distinct sections of the mouse intestine. The absorption of zinc alone (control) is compared to the absorption of zinc in the presence of typical CHD-FA concentrations expected in the GIT.

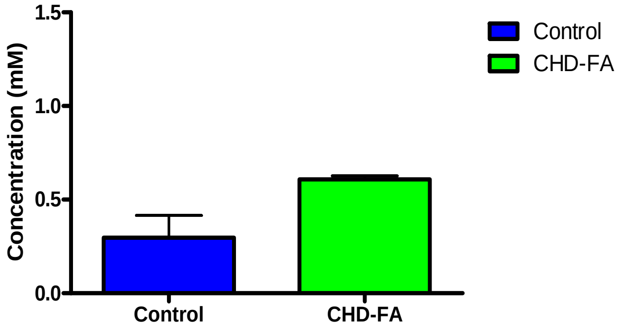
Graphs 5a-dshow the comparison of absorption between mineral alone or combined with CHD-FA for the individual intestinal segments (duodenum, jejunum, Ileum and colon).

Graph 5e shows the combined results of **graphs 5a-d**.

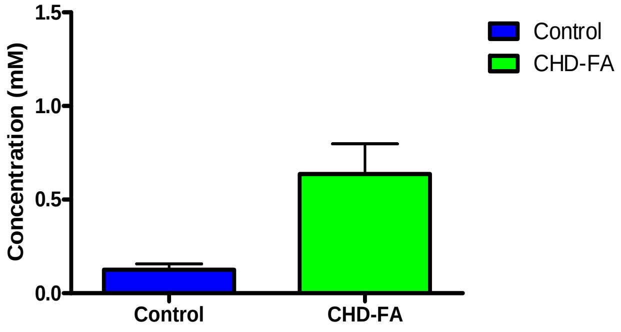
An increase in the zinc absorption in the presence of CHD-FA was seen in all GIT segments.

The ileum (**Graph 5c**) showed the greatest difference zinc in absorption.

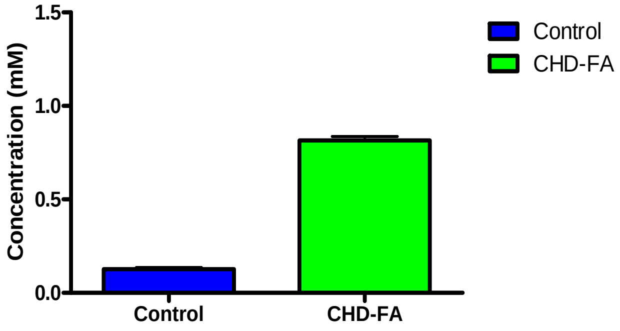
Zinc



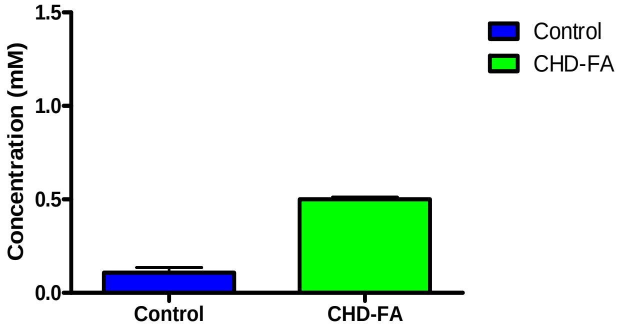
Graph 5a: Zinc absorption in the duodenum



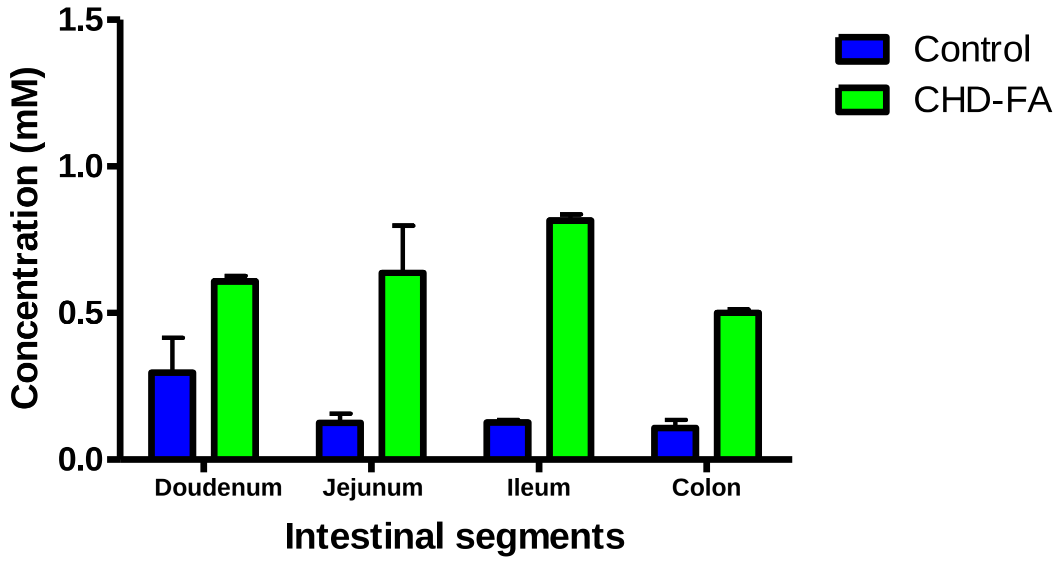
Graph 5b: Zinc absorption in the jejunum



Graph 5c: Zinc absorption in the ileum



Graph 5d: Zinc absorption in the colon



Graph 5e: Comparison of zinc absorption across the different intestinal segments